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PROGRESS REPORT ON THE DEVELOPMENT OF NEW TEST EQUIPMENT FOR CEAL

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PROGRESS REPORT ON THE DEVELOPMENT OF NEW TEST EQUIPMENT FOR CEAL

by

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SUMMARY

This report describes the following apparatuses: 1) electrostatic; 2) flammability limit, and 3) impact.

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INTRODUCTION

It is important for a research and certification laboratory such as Canadian Explosive Atmospheres Laboratory (CEAL) to keep up with equipment and measurement improvements made outside Canada. To do this requires an evaluation of these new apparatuses for their applicability to Canadian requirements. As part of this ongoing program, this report describes the progress made in developing three new pieces of test equipment for: 1) determining the static electricity hazard of non-metallic materials; 2) measuring the limits of flammability of gases and vapours; and 3) determining the impact ignition hazards of aluminum components.

ELECTROSTATIC APPARATUS

Non-metallic materials used in hazardous environments are usually rendered antistatic, to prevent ignition of the explosive gas. Currently, conveyor belts, ducts and pipes used in Canadian underground coal mines are tested at CEAL for their antistatic property by measuring the surface resistance of the material (1). This method is taken from the National Coal Board (U.K.) specification 158. An alternative test has been developed in Poland (2). To the best of our knowledge, the method has not been adopted elsewhere though it has been submitted to the International Electrotechnical Commission, Technical Committee No. 31 in June 1981. The principle of the method is to charge the surface of the test material by bombarding it with dust at a high velocity. The resultant charge is transferred to a spark gap electrode in a separate chamber filled with an appropriate explosive gas mixture. The advantage of this test is stated to be that it is a more direct measure of the actual hazard.

The purpose of our work is to independently evaluate this method. If it turns out indeed to be a better method than our current tests, it would be recommended for use in routine certification work.

A diagram of the apparatus is shown in Fig. 1. The apparatus has been built and installed by the Technical Services Division (see Fig. 2). Preliminary experiments have produced up to ca. 10 kV surface charge, using rust dust, but no spark has been observed. Work is in progress on this aspect.

FLAMMABILITY LIMIT APPARATUS

The existing CEAL flammability limit apparatus was based on the Coward-Jones apparatus (3). The new one is based on the ASTM Method E681-79 (see Fig. 3). The advantages of the latter are:

1. It is a "standard" method, therefore, data obtained with it will be more acceptable and can be compared to data obtained elsewhere.
2. The radius of the reaction vessel is 10.6 cm compared to 2.5 cm for the Coward-Jones apparatus. This is important to minimize quenching of the flame by the walls, which can occur for fuels with low burning velocities (e.g., halogenated compounds).
3. The upwards, downwards and horizontal flammability limits can all be determined, rather than just the upwards.
4. The reaction vessel can be easily dismantled for cleaning or replacement.
5. The system is mercury-free, which is especially desirable for higher temperature studies.

The chief limitation of the ASTM apparatus is that oxidizers stronger than air cannot be used because of the hazards involved. A stainless steel vessel would be required in that case.

The apparatus has now been constructed by the Technical Services Division, and only requires the spark ignition components. The apparatus consisting of that shown in Fig. 4 plus an associated vacuum system and vacuum pump are mounted on a moveable cart. Trials on gases and vapours having well established flammability limits will be carried out within a few months. We would then be in the position of having the capability of this type of testing of gases or vapours of unknown flammability limits upon request.

IMPACT IGNITION APPARATUS

Whether or not aluminum should be allowed to be used in underground gassy mines is a subject of world-wide controversy. The thermite reaction of aluminum with rust (Fe_2O_3) during an impact produces incendive sparks that can ignite a methane-air mixture. The present Canadian policy is to prohibit aluminum almost entirely. Other countries are moving toward allowing aluminum

components, provided they have an adequate protective layer (4). The purposes of constructing an impact apparatus are:

1. To independently assess the hazards of aluminum and coated aluminum pieces under impact with rusty steel in an explosive atmosphere, which will lead to recommendations on a new policy regarding aluminum in gassy mines.
2. To have the capability of demonstrating the hazards to interested parties.
3. To certify aluminum equipment according to the rules set up as a result of 1 above.

The detailed drawings of the apparatus are being drawn up now by the Technical Services Division. A sketch of the proposed apparatus is attached (Fig. 4). The electromagnet holds the dropweight in place at the desired height, as read on the drop height tape. The polycarbonate box is sealed off with polyethylene film and filled with the explosive gas mixture. On opening the electromagnet circuit, the drop weight is released and falls freely through the tube, breaks the thin polyethylene film on the top of the polycarbonate box, hits the sample and slides out the open side. The space between the bottom of the tube and the top of the box is to allow escape of the air being pushed ahead of the drop weight, so that the concentration of the gas mixture in the box will not change significantly. The angle of impact is fixed at 45°; sufficient previous work has proven that 45° is the most dangerous angle.

It is anticipated that construction and installation of the apparatus will be completed in six to eight months. Since this is not a standard apparatus, several additional months may be required to make it operational. The velocity of the drop weight near the point of impact will be measured (to compare with the theoretical), perhaps by interruption of a light beam shining on a photocell.

ACKNOWLEDGEMENT

The design of the electrostatic apparatus was carried out by Mr. S. Silver.

REFERENCES

1. Bossert, J.A. "Certification services for underground mining equipment and materials"; CANMET Division Report ERP/MRL 80-21(TR); Sept. 1980.

2. Koldziej, J. "New methods for the assessment of hazardous electrostatis surface charges collected on plastics intended for use underground in gassy mines"; presented at the 17th International Conference of Safety in Mines Research, Bulgaria; Oct. 1977.

3. Coward, H.F. and Jones, G.W. "Limits of flammability of gases and vapor"; U.S. Bureau of Mines, Bulletin 503; 1952.

4. Rauch, K.H. "The research and development progect 'Light alloy underground'"; Gluckauf-Forschungshefte, 42(2), 65; 1981. (Health and Safety Executive Trans. No. 9959).

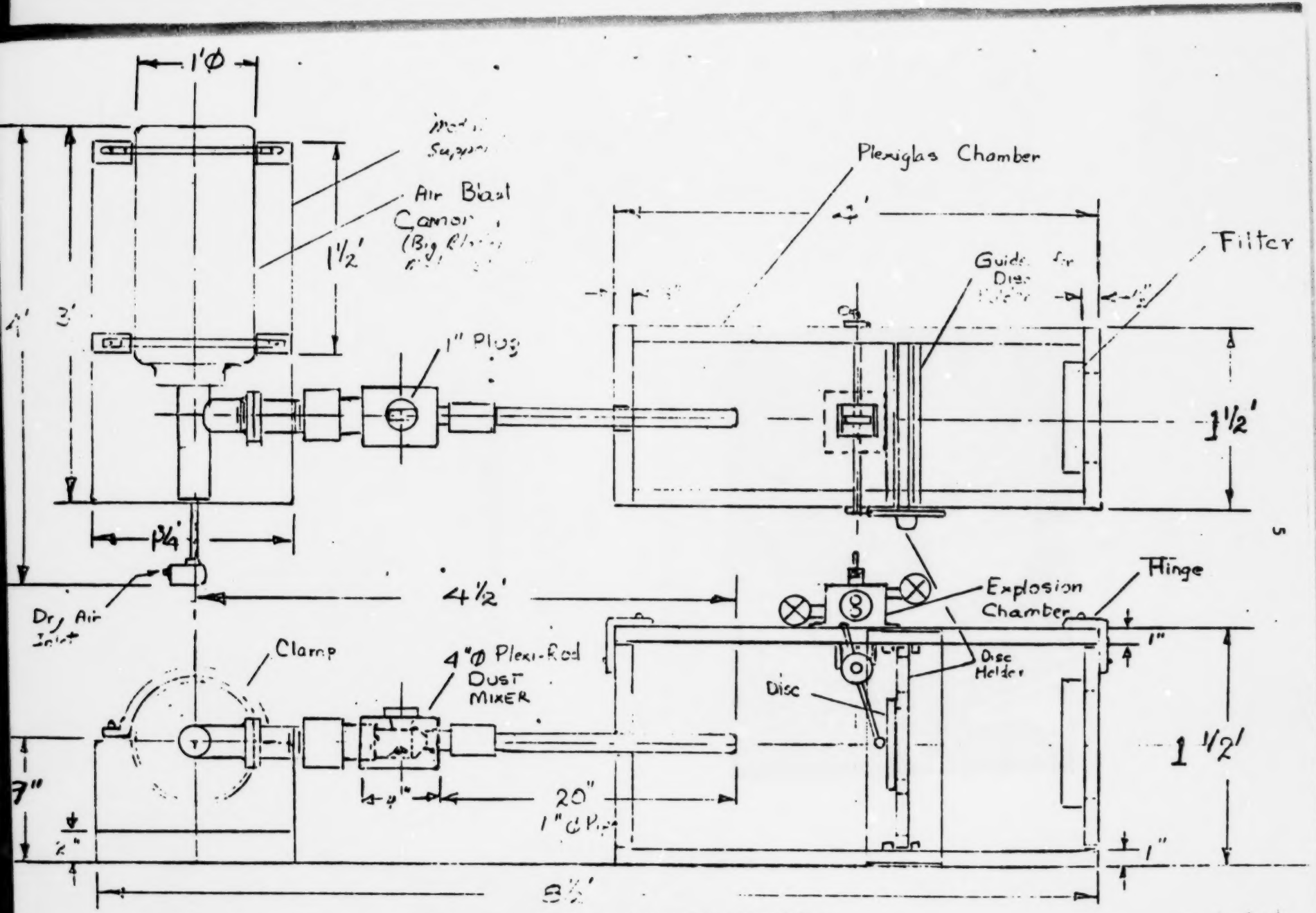

Fig. 1 - Apparatus for dust bombardment of dielectric materials.

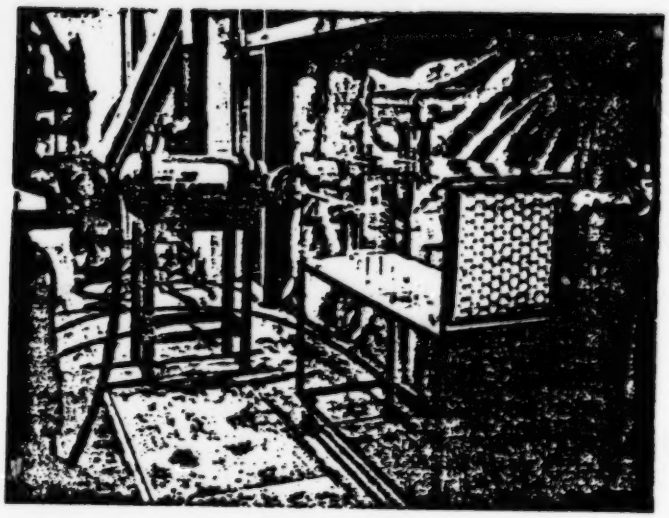

Fig. 2 - Electrostatic apparatus

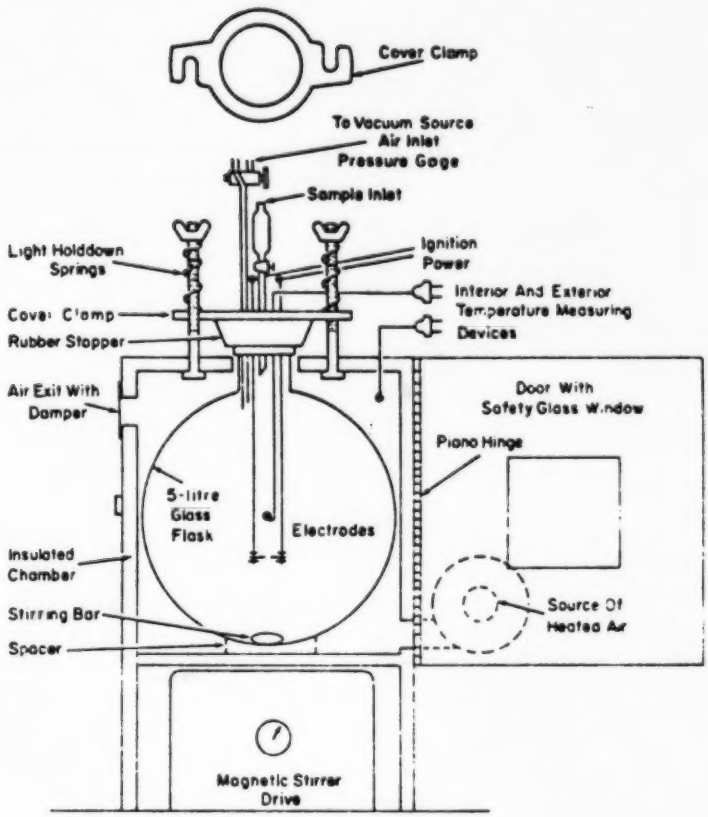

Fig. 3 - ASTM flammability limit apparatus

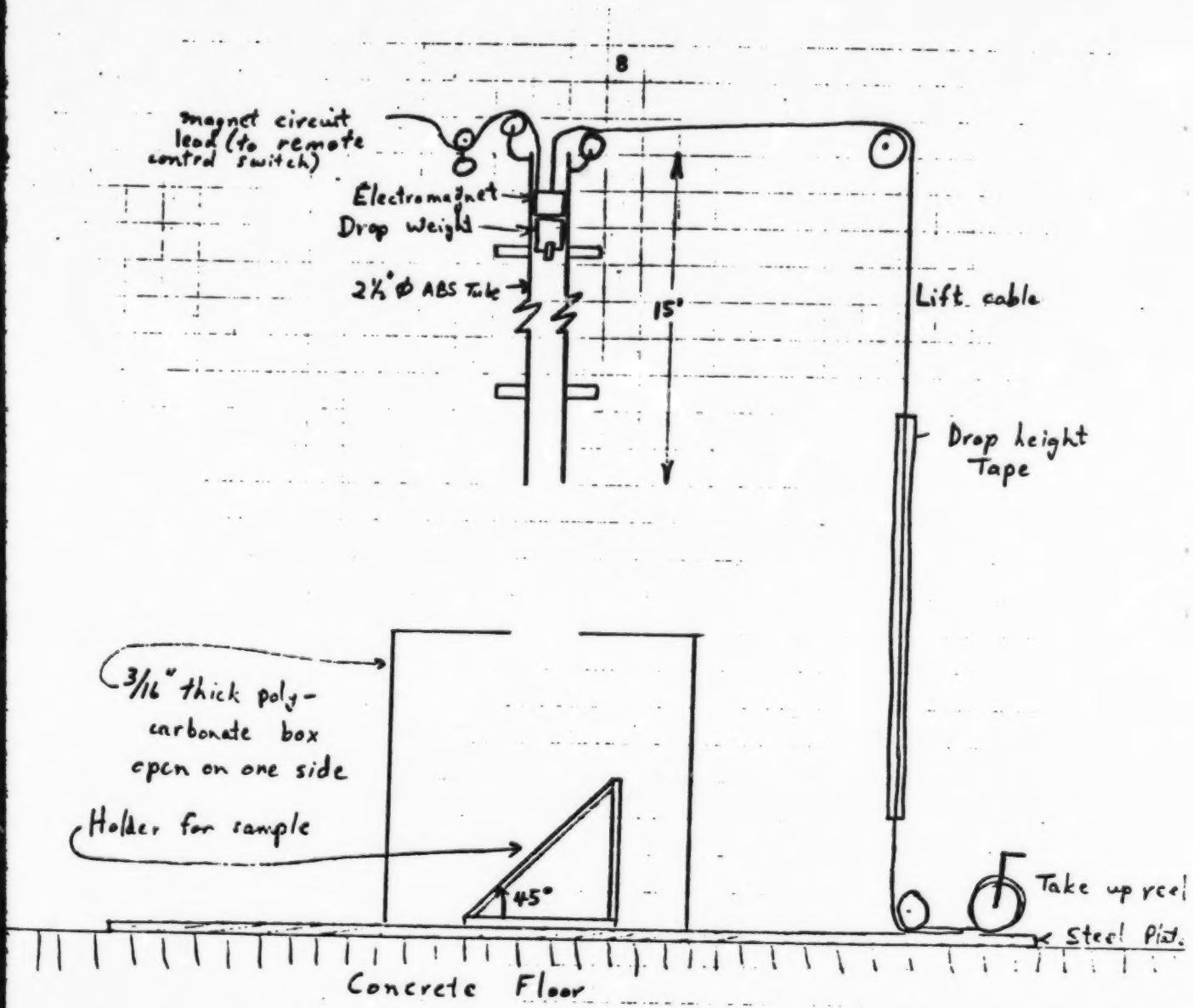

Fig. 4 - Impact ignition apparatus.